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## G. J. Billberg's (1833) 'On the ichthyology, and description of some new fish species of the pipefish genus *Syngnathus*'

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### Abstract

Gustaf Johan Billberg's review of ichthyology, published in Swedish in 1833 in the *Linnéska samfundets handlingar*, mentions 92 fish taxa at genus and species level, 41 of which represent new taxa, unnecessary replacement names, or unjustified emendations. Billberg presents his own classification of fishes, in which five new family names are introduced: Ballistidae, Diodontidae, Ooididae, Chironectidae, and Macrorhynchidae. Diodontidae has priority over Diodontidae Bonaparte, 1835. Macrorhynchidae was published earlier than Gempylidae Gill, 1862, but the latter has priority by prevailing usage.

Billberg mentions 61 genera of fishes, 41 of them listed only by name. Six generic names proposed by Billberg are available as unjustified emendations: *Myxinus*, *Petromyzus*, *Scylia*, *Mustellus*, *Zyganna*, and *Ballistes*. *Brachionus* is an unnecessary replacement name. *Aphrus*, *Capriscus*, *Exormizus*, *Enneopthalmus*, and *Oedusa* are nomina nuda. Eight new genera of fishes are proposed: *Anodon*, *Posthias*, *Orbis*, *Sphaeroides*, and *Ooides* are junior synonyms; *Cotilla* is a nomen oblitum in relation to *Sufflamen* Jordan, 1916; *Tropigaster* a nomen oblitum in relation to *Aracana* Gray, 1835; and *Tetragonizus* a nomen oblitum in relation to *Lactoria* Jordan & Fowler, 1902.

Billberg lists 31 species of fishes. Three represent new combinations; two are nomina nuda. The following 14 new species are described based on literature: *Raja forskohlii*, *Cephaloptera dumerillii*, *Myliobatis lacepedei*, *Scylia russelii*, *Anodon macropterus*, *Cotilla frenata*, *Monacanthus blochii*, *M. sebae*, *M. cavieri*, *M. marcgravi*, *Tetraodon striatus*, *Orbis psittacinus*, *Orbis punctulatus*, and *Orbis guttatus*. All of those are invalid, except *Scylia russelii*, which is a species inquirenda. The following nine species group names are unnecessary replacement names and consequently invalid: *Raja arabica*, *Myliobatis rissoi*, *Scylia isabellina*, *Anodon cirrhosus*, *Anodon cornutus*, *Zyganna voracissima*, *Centrina broussonetii*, *Acipenser vulgaris*, and *Acipenser ichthyocolla*.

Three species of pipefishes of the family Syngnathidae are described and figured by Billberg from drawings of specimens observed on the Swedish West Coast. *Syngnathus virens* and *S. pustulatus* are junior synonyms of *S. typhle* Linnaeus, 1758. *Syngnathus palmstruchii* is a junior synonym of *Entelurus aequoreus* (Linnaeus, 1758).

**Key words:** Classification, New genera, New species, Sweden, Zoological Nomenclature

### Introduction

Gustaf Johan Billberg (1772–1844) was a Swedish official and a lay entomologist with wide-ranging interests in natural history. He exerted some influence on the study of natural history in Sweden, being for some time editor and publisher of popular works on Swedish animals and plants, *Svensk botanik* (Swedish Botany) (Quensel & Swartz, 1802–1843) and *Svensk zoologi* (Swedish Zoology) (Quensel & Swartz, 1806–1825). He authored an unfinished work on economic botany (Billberg, 1815–1816), a catalogue of his insect collection (Billberg, 1820) and an unfinished work on the Scandinavian fauna (Billberg, 1827–1828), and published minor treatises on mammals, the fauna of Gotland, insects, collecting methods, and colour standards in natural history.

Billberg studied theology and law at Lund University in southern Sweden. His plans to eventually study medicine as a gateway to natural history were curtailed by the loss of the family fortune in 1790, forcing him to move to Stockholm and find an employment. There, and for some time on the island of Gotland, he held various positions in the naval, military, juridical, and social services, privately initiating numerous projects in botany and zoology.

Billberg was in possession of a large general natural-history collection (Löwegren, 1952). It included a major insect collection that was lost, along with his books, in a fire in 1822. Soon after that, however, he amassed a new insect collection, which was sold in 1828 and eventually ended up in the Natural History Museum in London in 1839–1840 (Löwegren, 1952). He also had a large collection of birds, eventually bequeathed to the collections of the Royal Swedish Academy of Sciences in 1809 (Löwegren, 1952). There is no indication that Billberg was in possession of a significant collection of fish specimens, but he donated two fish specimens to the Academy in 1800. One is a juvenile dried shark from “India”, tentatively identified as *Stegostoma fasciatum*, still preserved in the collection of the Swedish Museum of Natural History. The other specimen is probably lost. It was a sword (upper jaw) of a swordfish, *Xiphias gladius*, from Gotland.

In 1817 Billberg was elected member of the Royal Swedish Academy of Sciences, marking the height of his scientific career. After that his life went downhill. In 1821 he lost his country house to debts, and soon thereafter his new house in downtown Stockholm was lost in the fire of 1822. Shortly thereafter the Academy took over the publication of the series of Botany and Zoology books which had declined considerably in quality under Billberg’s editorship. Billberg was declared bankrupt in 1841 and died, ill and in misery, in November 1844.

Billberg’s zoological and botanical work is now for the most part more than obsolete. His hortological ambitions, however, are conspicuously manifest today in *Floras kulle* (Flora’s hill), a small elevated flowerbed area in the Humlegården garden in downtown Stockholm, created by Billberg and named for his daughter Flora. Ironically, the hill is now topped by a statue of the chemist Carl Wilhelm Scheele (1742–1786) and Billberg ranks among the least known of early 19<sup>th</sup> Century Swedish naturalists. Boethius (1924) and Landell (1999) provide biographical information on him.

Billberg was a devoted late Linnaean and founded a Linnean Society (*Linnéska Samfundet*) in Visby, Gotland, in 1806. It seems not to have been very active in that remote location, but Billberg revived it in Stockholm in 1832. The society was not endorsed by the academics and was terminated upon Billberg’s passing. (The present-day Swedish Linnaeus Society — *Svenska Linnésällskapet* — dates to 1917 and is completely independent from Billberg’s initiative.)

Billberg’s Linnean Society produced a single publication, the Transactions of the Linnean Society (*Linnéska Samfundets Handlingar*) which are limited to a single issue, for the year 1832, published in 1833. All papers in this issue are authored by Billberg. One of them is titled *Om Ichthyologien och Beskrifning öfver några nya Fiskarter af Samkäksslägtet Syngnathus* [On the Ichthyology, and Description of some new fish species of the pipefish genus *Syngnathus*] (Billberg, 1833). It was read to the Society on 2 February 1833. Although this paper contains no less than 46 new scientific names and detailed descriptions and figures of three new species of pipefishes, the existence of this paper seems to have passed almost unnoticed until this day. It was never cited in Swedish faunas or primary ichthyological literature, and was known mainly from the citation in the catalogue of early Swedish ichthyological literature by Lundberg (1872), and from the brief mention in Dal’s (1996) review of Swedish zoological literature. Because it contains a considerable number of new names and three neglected species descriptions it may merit a summary in English, which is the objective of the present paper.

## Material and methods

Two copies of the *Linnéska Samfundets Handlingar* were examined, both softbound, uncut, with blue wrappers typical of the period. Publications of all authors referenced by Billberg were examined for verification of the sources of the scientific names that he uses, and all names also cross-checked with the *Catalog of Fishes* (Eschmeyer & Fricke, 2015), and van der Laan *et al.* (2014). Relative validity of taxa follows Eschmeyer & Fricke (2015) unless otherwise stated. Availability of names was assessed in relation to the International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature, 1999), henceforth referred to as the Code. References to support prevailing usage of junior synonyms were searched in Zoological Record 1971–2011, accessed through the OVID database (<http://www.ovid.com/site/about.jsp>), and the Google Scholar search engine (<http://scholar.google.se>).

Below I report on all taxa mentioned by Billberg (1833). To facilitate reference, I first provide his classification in indented form, followed by a list of new family-group names. I then list all the genera, followed by all the species mentioned by Billberg in the order they are mentioned in Billberg’s paper. Billberg provides his classification in running text, first listing the orders with their diagnoses, followed by the family-group names of

each order, and a list of the genera included in each order. After each such account of an order follows indented remarks sections which provide additional comments, particularly on the etymology of the generic names, suggestions for better names, mention of species in each genus, and suggestions for better names for those species. Billberg uses italics for Swedish vernacular names and, with exceptions, author names; regular font for scientific names and person names when not indicating authorship; and Greek letters for Greek names. For clarity, I here use italics for available generic and species names, and regular letters for person names, taxon names above the genus-level, and unavailable taxon names. Greek names are kept in Greek letters, and the Latin ligand æ is kept as in the original where relevant. For each genus and species name I have added the currently valid family name. Person names misspelt by Billberg have been corrected. For most taxa Billberg also provides Swedish names, which occasionally provide a clue to the understanding of a scientific name, as they often carry identical meaning.

Billberg probably used only two works for his references, La Cépède (1798) and Cuvier (1816). In his enumeration of taxa, he gives many references to other authors, and all such ultimate sources were searched and references added as far as possible.

## Results

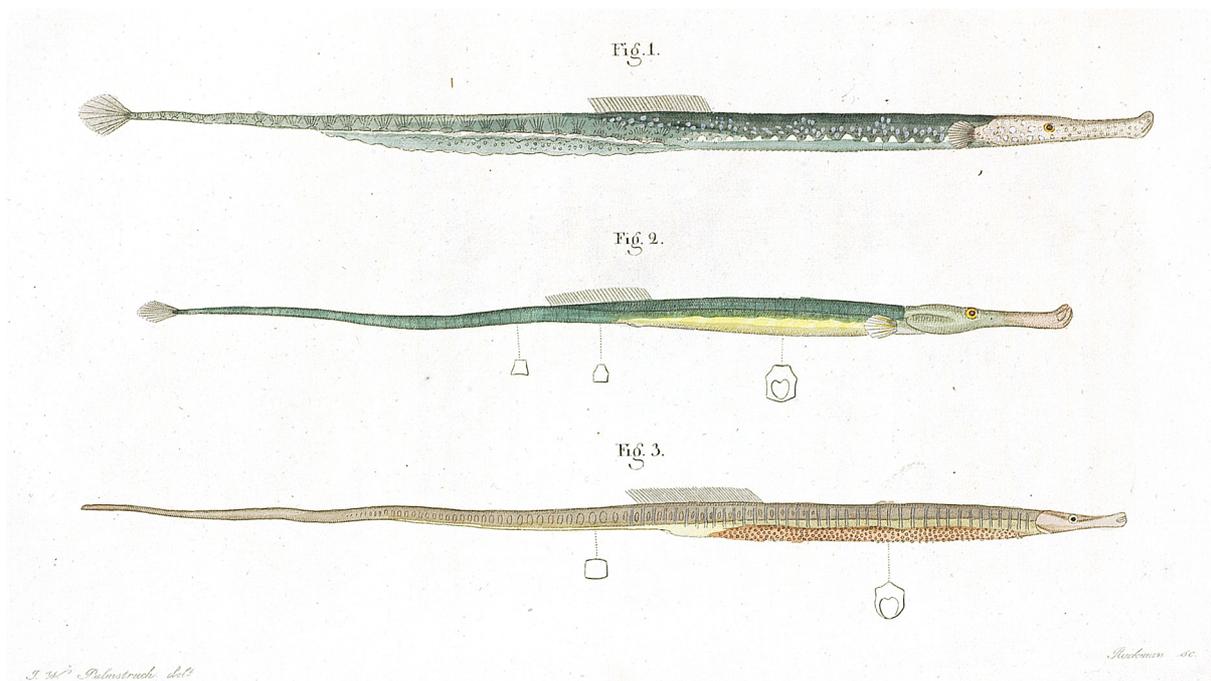
Billberg (1833) begins with a brief introduction to fish classification. He laments the lack of a system or classification of the fishes, especially since “almost all other classes in Natural History have been examined and analysed with “utmost accuracy”, and goes on to propose his own classification in some detail. He objects to the use of the term family, introduced in zoology by Latreille (1796) for groups of genera, arguing that a family consists of a male and a female and their offspring, and instead proposes *natio* (plural *nationes*) as a suitable term (developed from a Swedish construction, *Slägtslag*, which can be translated into Kind of kin or Kin-kind). Billberg’s names of families (*nationes*) all end in *-iides*, except three based on a generic name ending in *-a*, which become *-æides*. The terms *flock* and *skock* for hierarchical levels between order and *natio* are Swedish words which both refer to aggregations (flock, herd, crowd, pack), and are not explained by Billberg.

Billberg considers three subclasses of fishes, viz., cartilaginous, soft-rayed, and spiny-rayed fishes. He goes into detail in listing all orders and families, and apparently all genera of cartilaginous fishes that he recognizes. The other two subclasses are not treated in the same detail. The text is rich in references to Ancient Greek and Roman authors, pre-Linnaean renaissance authors, and a selection of late 18<sup>th</sup> and early 19<sup>th</sup> Century ichthyologists (Linnaeus, Gmelin, Bloch, La Cépède, Duméril, Cuvier ...), but no explicit source references are given.

The paper is clear and concise for about the first two pages. The rest is relatively poorly structured and includes spelling errors and variation in spelling of personal names. Pages 51–54 consist mainly of mention of fish names of earlier authors, to a large extent with a suggestion for a replacement name. From page 53, at the end of the “remarks”, the taxa are not as richly commented as earlier in the text and the list is also inconsistent with the enumeration on p. 52. Occasionally it is unclear whether Billberg is proposing a replacement name or a new name, and on p. 53 he forgets to mention species for two new generic names. Taxa are assigned to his subclass Chondrichthyes, which includes a number of actinopterygians, but no contained taxa are mentioned for the subclasses Malacichthyes (presumably non-acanthopterygian teleosts) or Acanthichthyes (presumably corresponding to Acanthopterygii).

The paper ends with the descriptions and illustrations of three new species of pipefishes, family Syngnathidae. The illustrations are reproduced here in Fig. 1.

In his introduction Billberg makes numerous references to authors: Linné, Artedi, Bloch, Schneider, La Cépède, Duméril, Cuvier, Aldrovandi (p. 47), Retzius, Quensel, Thunberg, Hollberg, Blainville (p. 48), Nilsson, Ekström, Schagerström (p. 49), but few works are listed with a title. Additional authors are listed in the taxonomic section. One gets the impression that Billberg’s sources of information are limited and somewhat dated. Apart from the pipefishes, he does not mention anything about Swedish fishes, or provide any information identifiable as coming from any of the several Swedish authors listed, except Linnaeus. He makes numerous references to Cuvier, Duméril, and La Cépède. Cuvier (1816, 1829), Duméril (1805), and La Cépède (1798) were important works in the early 19<sup>th</sup> Century. Billberg gives references only to the first of the five volumes of La Cépède’s *Histoire naturelle des poissons* (La Cépède, 1798). This is remarkable since Billberg was a book collector (Dal, 1996; Landell, 1999), but perhaps fish books were not prioritized.



**FIGURE 1.** Reproduction of the plate in Billberg (1833): fig. 1 *Syngnathus pustulatus*; fig. 2, *Syngnathus virens*; fig. 3 *Syngnathus palmstruchii*.

Except for the three new pipefish names, the new genus and species level names proposed by Billberg fall into five categories:

- 1 Replacement names (*nomina nova*, substitute names). Such are occasionally explicit, but usually evident because they are used in the enumeration of taxa and the reason for rejection of the existing name is explained in the comments on the enumeration. An example is *Centrina Broussonetii* as a new name for *Squalus americanus* Gmelin. Expressly proposed replacement names are available with their own author and date (Code Article 13.1.3). They can be valid only when replacing a junior homonym (Code Articles 52, 60, 72, 75). All other replacement names are junior objective synonyms and invalid, and take the same type as the name substituted.
- 2 Unjustified emendations. In numerous cases Billberg corrects an available name, although there is no obvious error in the original. An example is *Petromyzus* which is a modification of *Petromyzon* Linnaeus, 1758. Unjustified emendations are covered in the Code, Article 33, which states that such emended names are available names with their own author and date. Where no justification is presented by Billberg and his spelling of a name differs from that otherwise used for a genus or species, it is considered to be an incorrect subsequent spelling without nomenclatural status.
- 3 Explicitly new taxa named as such are available from Billberg (1833). Those include *Monacanthus Blochii*, based on a drawing in Bloch (1786: pl. 148), which Billberg considers incorrectly identified as *Balistes tomentosus* Linnaeus.
- 4 Application of pre-1758 names. Billberg frequently refers to sources published before 1 January 1758, i.e., before the starting date of the Code, which consequently are not available (Code Article 3). Citation of such names does not make them available or change the authorship of the name. When citing a name for which there is an identical or similar post-1757 available name, Billberg's usage is best interpreted as an explanation of the origin of a name. *Ammocoetus*, credited to Gesner (1598), should be understood as the same as *Ammocoetus* Duméril, even though Gesner used the name for a species of the Ammodytidae, and Duméril used it for the larva of the Petromyzontidae. When explicitly changing the spelling of a name and referring to a pre-1758 source, however, Billberg is performing an unjustified emendation as explained above. In several cases, however, Billberg is adopting a pre-1758 name as his own, such as *Zyganna*, which then takes authorship from Billberg. The Code (Article 12.2.1) permits an author to adopt pre-1758 non-binominal names as available with the author, not the source, as author of the name.

- 5 Latinization of post-1757 vernacular names. La Cepède and other early French authors commonly used names in French or gallicized Latin or Greek, instead of Latin names for families, genera and species. Such names were successively replaced with Latin counterparts during the first half of the 19<sup>th</sup> Century. An example is *Sphaeroides* Billberg from *Sphaëroides* in La Cepède (1798). Kottelat (2013: 290) has discussed at length whether Cuvier's generic names in French form (gallicized Latin or Greek) should be considered available as first published or only from the subsequently latinized form and how to deal with names that are neither Latin, Greek or French. Billberg latinizes many names that are given in French form in La Cepède (1798). When the text of a work, such as that of La Cepède (1798), is almost entirely in French and also the taxon names are given in unmistakable French form and sometimes also given Latin equivalents already in the source, I consider it obvious that the taxon names in French form are proposed as vernacular or common French names, and not as binominal scientific names.

The classification. Billberg's classification is as follows, with the diagnosis, where given, translated:

1 subclass: Chondrichthyes (cartilaginous skeleton)

A Order Apteri (no fins)

1 flock Cyclostomi

Natio Myxiniides (two breathing holes in the throat and 8 gills)

Natio Petromyziides

B Order Chondropteri (cartilaginous fins)

1 flock Hypostomi (mouth below, transverse)

1 skock Trematopnei (several rounded breathing holes)

Natio Rajæides

2 skock Schismatopnei (wide cleft or one single breathing hole and gill membrane, but without gill cover)

Natio Chimerærides

3 skock Pomatopnei (breathing hole and gill cover, but either with or without gill membrane)

Natio Squaliides

Natio Acipenseriides

Natio Pegasiides

C Order Schiponopteri (rayed fins)

1 flock microstomi [sic] (small, not extensible mouth)

Natio Ballistiides

Natio Diodontiides

Natio Ostraciides

Natio Tetraodontiides

Natio Ooidiides

Natio Chironectiides

2 flock Platystomi (large, wide mouth)

Natio Lophiides

Natio Cyclopteriides

Natio Echeneiides

3 flock Aphyostomi (extended mouth)

Natio Syngnathiides

Natio Fistulariæides

Natio Macrorhynchiides

2 subclass Malacichthyes (bone-hard skeleton and soft-rayed fins)

[No included taxa listed.]

3 subclass Acanthichthyes (bone-hard skeleton and spinelike rayed dorsal fin)

[No included taxa listed.]

**Family names.** Most of the family names used by Billberg (1833) were already available at the time. Some family names are new, however:

Ballistiides, p. 52, here corrected to Ballistidae, based on *Ballistes* Billberg, 1833, is a junior synonym of Balistidae Rafinesque Schmaltz (1810b: 41).

Diodontiides, p. 52, here corrected to Diodontidae, based on *Diodon* Linnaeus, 1758 is an available family name, senior synonym of Diodontidae Bonaparte (1835: 6).

Ooidiides, p. 52, here corrected to Ooididae, based on *Ooides* Billberg, 1833, is an available family name, senior synonym of Ovoidinae Whitley (1959: 322), and secondary junior synonym of Tetraodontidae Bonaparte (1831: 97).

Chironectiides, p. 52, here corrected to Chironectidae, based on *Chironectes* Cuvier, 1817, is an available family name, senior homonym of Chironectidae Swainson (1838: 201), junior synonym of Antennariidae Jarocki (1822).

Macrorhynchiides, p. 52, here corrected to Macrorhynchidae, based on *Macrorhynchus* Duméril (1805), is an available family name, senior synonym of Gempylidae Gill (1862). Billberg uses the incorrect subsequent spelling *Macrorhynchus*. Macrorhynchidae Duméril has not been used as a valid name after 1899 whereas Gempylidae has been used in at least 100 publications between 1976 and 2011, by more than 25 different authors (Zoological Record, 2015-09-14). With reference to Code Article 23.9.2, Gempylidae is therefore the valid name and Macrorhynchidae invalid whenever the two are regarded as synonyms. Macrorhynchidae Koken, 1887 (in Archosauria), based on *Macrorhynchus* Dunker, 1844, is not a junior homonym of Macrorhynchidae, but apparently also not in use as a valid name.

**The genera and species.** Billberg does not present any general method for treating names of genera and species, but in the commented enumeration of genera and species on pages 50–52, he explicitly corrects the spelling of seven names, and explicitly replaces 28 names, including both pre-1758 and later names. In many cases the change is motivated by the mere existence of pre-1758 usage of a name. The primary sources stated are Aristoteles and Plinius, but also Oppianus, Cassiodorus, Gesner, Belon, Athenaeus, Artedi, Marcgravius, Aristophanes, Klein, and Clusius are mentioned. Mention by Billberg of a pre-1758 name as having authorship from a pre-1758 author (e.g., Raia Bellonius, 1553) can be understood as conferring availability of that name with Billberg as author. In all of those cases, however, there is a post-1757 available instance of the name and the alternative interpretation, that Billberg is only referring to the historical origin of the name, is equally valid and preferred here.

Among species, Billberg makes numerous replacement names for existing binominal names, all unjustified and thus available names, but automatically junior synonyms of the “bad” name. He gives principally one or both of two reasons: the name is inappropriate or incorrect, or there is a pre-Linnean name.

*Myxinus*, p. 50, represents a corrected spelling of *Myzine*, which apparently is Billberg’s misspelling of *Myxine* Linnaeus, 1758. Billberg refers to the Greek name *Μυζινόσ* for justification. *Μυζινόσ* is mentioned as a slimy fish by Athenaeus (Deipnosophistae, book 7, section 306E). *Myxinus* is available as an unjustified emendation or replacement name for *Myxine* Linnaeus (1758), and is permanently invalid being a junior objective synonym of *Myxine* Linnaeus, 1758. Myxinidae.

*Ammocoetus*, p. 50, is credited to Gesner but is obviously the same as *Ammocoetus* Duméril (1812a, b: 16), representing the larva of lampreys. Gesner, however, applied this name on sand-eels, members of the family Ammodytidae (Gesner, 1598: 39). Petromyzontidae.

Exormizus, p. 50, is said to refer to a name already used by Cassiodorus, “Exormizo, ἐξορμίζω solvo a littore”. Cassiodorus’ letters contain multiple references to *exormiston*, a fish found at Rhegium (Reggio, southern Italy), similar to an eel (muraena) (Thompson, 1947: 297; Hodgkin, 1886: 503). Because information in Cassiodorus is insufficient to recognize the species concerned, and because Billberg only identifies it by a Swedish name (“strandgräfling), possibly his own invention or just a translation of Exormizus, it must be regarded as a nomen nudum, unavailable specifically by Code Article 12.3.

Enneophthalmus, p. 50, credited to Willughby, refers to Lampetra no. 5 in Willughby (1686: 107, pl. G3, fig. 1), which in turn refers to a drawing by Leonhard Baldner (1666–1687, 1974) of Ein Blinder Neünhockhen, translated by Willughby as Enneophthalmos caecus (i.e. blind nine-eyes). This is the only place where Willughby (1686) uses the word Enneophthalmus. Willughby’s own name for this fish is Lampetra caeca seu oculis carens, given simply as Lampetra caeca on his plate G3. Baldner’s work, an illustrated regional fauna of the Strasbourg

area, is known from five manuscripts, of which one obtained by Willughby (Baldner, 1974). Another copy was reprinted in 1974 (Baldner, 1974). The drawing of the Blinder Neünhockhen is at the bottom of a plate with altogether four drawings of lampreys. The upper three, with the header Dreÿerley Sehender Neünhockhen, are probably adult *Lampetra planeri* Bloch, 1784 as suggested by Lauterborn *et al.* (1974). The bottom fish is captioned “Ein Blinder Neünhockhen” [“a blind lamprey”] and may be an ammocoetes larva. It has a lamprey-like form with gill apertures represented by a series of black dots along the side of the head, and it lacks a dorsal fin. The eye is a prominent feature in the upper three drawings, but is absent in the “Blinder”. Consequently, the Enneophthalmos caecus is the ammocoetes larva of one of the three north European lamprey species, most likely *L. planeri*. Billberg writes that Enneophthalmus “belongs here [to Petromyziides] but is incorrectly used by Willoughby for Ammocoetus”. By this should be understood that Billberg criticizes Willughby for applying Enneophthalmus, in the meaning of nine eyes, on the ammocoetes stage of lampreys (the larval form of lampreys, which does not have visible eyes) Billberg misses the point that Willughby only translated Baldner’s name and it explicitly describes a blind lamprey. Billberg applies Enneophthalmus on species known as Neunaugen in German and Nejonögon in Swedish (“Neinöga” in Billberg), i.e. “nine eyes”, which excludes the ammocoetes larva but applies to adults of species of *Lampetra* Bonnaterre, 1788 and *Petromyzon* Linnaeus, 1758. Because Billberg explicitly excludes the species referenced by Willughby (“Enneophthalmos caecus”), lists *Petromyzon* as distinct (as *Petromyzus*, see below), and does not explain clearly which species are included or which characters are diagnostic for his Enneophthalmus, the name is a nomen nudum (none of the indications in Code Article 12.2 applies). Mention of “Neinöga” is not sufficient for an indication (Code Article 12.3).

*Petromyzus*, p. 50, is presented as a corrected spelling of *Petromyzon* credited to Linnaeus. *Petromyzus* is available as an unjustified emendation of *Petromyzon* Linnaeus (1758), and is permanently invalid, being a junior objective synonym of *Petromyzon* Linnaeus, 1758. Petromyzontidae.

*Torpedo*, p. 51, is credited to Plinius. Plinius (book 9, chapters 16, 24, and further) mentions a fish called torpedo. This is probably the same as *Torpedo* Duméril (1805: 102). Torpedinidae.

*Raja*, p. 51, is credited to Bellonius. In Bellonius (1553: 79) and Belon (1555: 70) it is spelt Raia. Plinius (book 9, chapters 24, 42) mentions raia in a list of batoid chondropterygians, so Belon is just adopting a vernacular Latin name. This is probably the same as *Raja* Linnaeus (1758). Rajidae.

*Rhinobatus*, p. 51, is credited to Schneider. It is the same as *Rhinobatus* Schneider (1801: 353), a junior synonym of *Rhinobatos* Linck, 1790. Rhinobatidae.

*Myliobatus*, p. 51, also spelt *Muliobates*, is credited to Duméril. It is apparently the same as *Myliobates* Cuvier (1816: 137). Cuvier cites Duméril as source of the name. Myliobatidae.

*Cephaloptera*, p. 51, is credited to Duméril. It is apparently the same as *Cephaloptera* Cuvier (1816: 138). Cuvier cites Duméril as source of the name. It is a junior synonym of *Mobula* Rafinesque Schmaltz, 1810. Myliobatidae.

*Chimaera*, p. 51, is credited to Linné. It is the same as *Chimaera* Linnaeus, 1758. Chimaeridae.

*Callorhynchus*, p. 51, is credited to Gronovius. Callorhynchus in Gronovius (1754: 59) was made available as *Callorynchus* Cuvier (1816: 140). Billberg’s mention of the genus is thus considered to be an incorrect subsequent spelling of *Callorynchus* Cuvier, 1816. *Callorhynchus*, attributed to La Cépède (1798: 400) (Eschmeyer & Fricke, 2015), is not made available there, but that spelling is apparently in prevailing usage. Callorhynchidae.

*Lamna*, p. 51, is credited to Cuvier. It is the same as *Lamna* Cuvier (1816: 126). Lamnidae.

*Selache*, p. 51, is credited to Cuvier. It is the same as *Selache* Cuvier (1816: 129), a synonym of *Cetorhinus* Blainville, 1816. Cetorhinidae.

*Cestracion*, p. 51, is credited to Cuvier. However, Les Cestracions in Cuvier (1816: 129) is a French construction, latinized as *Cestracion* Bosc (1816: 598). Bosc cites Cuvier as the source of the name. *Cestracion* Bosc, 1816 is a junior synonym of *Heterodontus* Blainville, 1806. Heterodontidae.

*Scylia*, p. 51, is proposed as a corrected spelling of *Scyllium* Cuvier, with the motivation that *Scylia* in Aristoteles (rendered Σκύλαξ by Billberg, but Aristoteles, book 6, chapter 10–11 uses σκύλιον) was unjustifiably changed to *Scyllium* by Cuvier. *Scylia* Billberg, 1833, is available as an unjustified emendation of *Scyllium* Cuvier (1816: 124), itself a junior objective synonym of *Scyliorhinus* Blainville, 1816. Scyliorhinidae.

*Galeus*, p. 51, is mentioned as used already by Aristoteles (Γαλεος in Aristoteles, book 5, chapter 10). Billberg does not mention any post-1757 usage, but he possibly has *Galeus* Rafinesque Schmaltz, 1810 in mind. Pentanchidae.

*Mustellus*, p. 51, credited to Aristoteles, is proposed as a replacement for *Mustelus* Cuvier, with the motivation that *Mustellus* in Aristoteles was unjustifiably changed to *Mustelus* by Cuvier. “In the same way *Galeus* (γαλεος, *Mustela*) is already used by Aristoteles for a shark species. *Mustellus* *Arist.* less suitably called *Mustelus* by Cuvier, as more confusing with *Mustela*.” Possibly, the period after species should be a comma. Actually, Aristoteles (book 5, chapter 10) uses γαλεος, translated by Gaza into *Mustelus* (cf. Artdi, 1738: *Synonymia*: 94). *Mustellus* Billberg, 1833, is available and invalid as an unjustified emendation of *Mustelus* Cuvier (1816: 128), itself a junior synonym of *Mustelus* Linck (1790: 31); and a junior homonym of *Mustellus* Risso (1827: 126), and potentially *Mustellus* Fischer (1813: 78), the latter, however, being on the Official Index (Melville & Smith, 1987) as an incorrect spelling of *Mustelus*. Triakidae.

*Anodon*, p. 51, is an available name, intended by Billberg to replace *Aodon* in La Cepède (1798: 297). *Aodon* must be understood as a French construction like most other names in La Cepède (1798), but has commonly been considered later to be a scientific name (e.g., Eschmeyer & Fricke, 2015). *Aodon* was first made available by Anonymous (1798: 675), later independently also by Rafinesque Schmaltz (1810b: 46) in the combination *Aodon cornutus*, with reference to La Cepède. La Cepède (1798: 297) describes three species of *Aodon*, viz., L’*Aodon* massasa, L’*Aodon* kumal, and L’*Aodon* cornu. The first two refer to *Squalus* massasa and *Squalus kumal* in Forskål (1775: X). The third is *Squalus edentulus* Brünnich (Brunnichius, 1780: 6) which is listed in La Cepède’s footnote. Billberg renames these species *Anodon macropterus*, *Anodon cirrhosus*, and *Anodon cornutus*, respectively, and the names are available but invalid, being unjustified replacement names. Fricke (2008) identified *S. kumal* as the same as *Nebrius ferrugineus* (Lesson) [*Scyllium ferrugineum* Lesson, 1831: 95], potentially in prevailing usage (Eschmeyer & Fricke, 2015; Fricke 2008). *Squalus* massasa is unavailable from Forskål, as it appears there under two names (massasa and mafreka; cf. below), but available as *Squalus messasa* Bonnaterre (1788: 13), although it is uncertain which species it represents (Fricke, 2008). *Squalus edentulus* has been identified as a myliobatid ray, probably *Mobula mobular* (Bonnaterre, 1788) (Notarbartolo-di-Sciara, 1987). Anonymous (1798: 678) latinizes *Aodon cornu* into *Aodon cornutus*, but places it in the synonymy of *Squalus edentulus* Brünnich. *Aodon cornutus* Anonymous was first published in synonymy but a synonym name becomes available if used as a valid name before 1961 (Code Article 11.6.1). Rafinesque Schmaltz (1810b: 46) was next to latinize La Cepède’s cornu as *Aodon cornutus*, probably independent of Anonymous (1798), but conferring validity to *Aodon cornutus* Anonymous. The first originally included species of *Aodon*, and therewith type species by monotypy is *Aodon cornutus* Anonymous. *Anodon* Billberg, 1833 antedates *Nebrius* Rüppell, 1837 and is a senior homonym of *Anodon* Agassiz, 1846, but is junior to *Aodon* Anonymous, 1798, *Mobula* Rafinesque Schmaltz, 1810, and *Aodon* Rafinesque Schmaltz, 1810. I select *Aodon cornutus* Anonymous as type species of *Anodon* Billberg. This act makes *Anodon* Billberg a junior objective synonym of *Aodon* Anonymous, and a junior subjective synonym of *Mobula* Rafinesque Schmaltz, 1810. *Anodon cornutus* Billberg is a junior objective homonym of *Aodon cornutus* Anonymous, and a junior objective synonym of *Squalus edentulus* Brünnich. Anonymous (1798a,b) is a review of La Cepède (1798). It uses the German words *Geschlacht* for genera, and *Gattung* for species. At the end of the review there is a note: “Wir haben die neuen Gattungen lieber in dieser Anzeige französisch nennen wollen, um Verwechslungen zu vermeiden, zumal da der Vf. selbst einen lateinischen Namen hinzuzusetzen unterlassen hat.” [To avoid confusion, we have preferred to name the new genera [=species!] in French in this announcement, especially since the author has himself omitted to add a Latin name.] Consequently, La Cepède’s new French genus names are accepted as available when latinized in that review (*Aodon*, *Ovoïdes*, *Sphaeroides*), but not the species names except *Aodon cornutus* for *Aodon* cornu. Myliobatidae.

*Zyganna*, p. 51, is introduced as a corrected spelling of the generic name *Zygaena* Cuvier, and the specific name in *Squalus zygaena* Linnaeus, 1758. “*Zyganna* is already adopted by Aelianus and Oppianus and should be so much less changed to *Zygaena* as the latter is a previously adopted generic name among insects.” *Zyganna* Billberg is an unjustified emendation of *Zygaena* Cuvier (1816: 127), preoccupied by *Zygaena* Fabricius, 1775 (Insecta), and a junior synonym of *Sphyrna* Rafinesque Schmaltz, 1810, *Cestrorhinus* Blainville, 1816, and *Sphyrichthys* Thienemann, 1828, all with *Squalus zygaena* as type species. Actually, ζυγαίνα is used by Aristoteles (book 2, chapter 15), and this name is rendered as *Zygaena* in Latin by renaissance authors (Artdi, 1738, *Synonymia*: 95). Sphyrnidae.

*Squalus*, pp. 51, 52, is only given the comment (p. 52) that “*Squalus* is [the name used by] the old Latin speaking”. It is the same as *Squalus* Linnaeus (1758), derived from Plinius (book 9, chapters 24 and 51), and Ovidius (*Halieutica*, v. 123), through Artdi (1738, *Philosophia*: 73; *Synonymia*: 94). Squalidae.

*Centrina*, pp. 51, 52, is credited to Athenaeus. It appears as κεντρίνην in Athenaeus book 7, 294d, and goes back to κεντρίνης in Aelianus (book 9). It is the same as *Centrina* Cuvier (1816: 130), which is a junior synonym of *Oxynotus* Rafinesque Schmaltz, 1810. Oxynotidae.

*Squatina*, pp. 51, 52, is credited to Plinius with the spelling Sqvatina. Plinius mentions Squatina in book 9, chapters 12, 24, 42, 51, and book 32, chapter 9. It is available as *Squatina* Duméril (1805: 102). Squatinidae.

*Pristis*, p. 52 is credited to the Ancients. The name appears in Plinius, book 9, chapters 3–4, and book 32, chapter 11. It is available as *Pristis* Linck (1790: 31). Pristidae.

*Spathularia*, p. 52, with Shaw as author, is considered by Billberg to be an older name than *Polyodon* Lacépède. *Polyodon* is from Lacépède (1797a: 49; 1797b:13), and *Spatularia* from Shaw (1804: 362), so the priority is certainly with *Polyodon*. *Spathularia* is obviously an incorrect subsequent spelling. Polyodontidae.

*Acipenser*, p. 52, is said to be an old Latin name. It appears in Plinius, book, 9 chapter 18, and book 43, chapter 11, and is also recorded by other Roman authors (Artemi, 1738: Synonymia: 91; probably based on Ἀκκιπηνσιος in Athenaeus (294C; cf. Thompson, 1947: 7; Artemi 1738; Synonymia: 91). It is available as *Acipenser* Linnaeus, 1758. Acipenseridae.

*Pegasus*, p. 52, is mentioned as Linnaeus's name, and is the same as *Pegasus* Linnaeus, 1758. Pegasidae.

*Ballistes*, p. 52, is referred to with Artemi as author. That could imply a new name, based on Balistes in Artemi (1738: Genera: 53; Synonymia: 82), but it seems more credible that the change in spelling concerns *Balistes* as adopted by Linnaeus (1758). *Ballistes* Billberg, 1833, is thus available as an unjustified emendation of *Balistes* Linnaeus, 1758. Billberg consistently uses Ballistiides and *Ballistes* but refers also to Artemi's spelling Balistes, and consequently *Ballistes* is not an incorrect subsequent spelling. Balistidae.

*Capriscus*, p. 52, is mentioned without species, although it is said that the name is from a species named capriscus by Linnaeus (“a Linnaeus's species name”) which probably should be understood as *Balistes capriscus* Gmelin (1789: 1471). Although one can assume that Billberg's Capriscus was intended for that species, it is not explicit, and Capriscus is therefore a nomen nudum as no species were included and no diagnosis given. Available *Capriscus* date to Artemi (in Röse, 1793: 114) and Rafinesque Schmaltz (1810b: 41). The name derives from Καπρίσκο in Athenaeus (Book 8, section 52; book 3, fol. 177, 25 according to Artemi, 1738: Synonymia: 114; 355 according to Thompson, 1947: 101). Balistidae.

*Cotilla*, p. 52, is an intentionally new genus for “Balliste bride” in La Cepède (1798: 378), named *Cotilla frenata* by Billberg (1833: 52). The Baliste bridé of La Cepède was already named *Balistes fraenatus* by Latreille (1804: 74) and *B. capistratus* by Shaw (1804: 417), and it is the type species of *Sufflamen* Jordan, 1916. *Cotilla* Billberg, 1833, is thus available and a senior synonym of *Sufflamen*. *Cotilla* has never been used as a valid name after 1833, whereas *Sufflamen* has been used in 42 publications between 1979 and 2011, by 33 different first authors (Zoological Record 2015-09-19). Therefore *Sufflamen* has priority over *Cotilla* whenever they are considered synonyms (Code Article 23.9.1–2). Balistidae.

*Monacanthus*, p. 52, is credited to Cuvier. It appears in Cuvier (1816: 152) as Les Monacanthes, but is latinized by Oken (1817: 1183) as *Monacanthus*. Monacanthidae.

*Triacanthus*, p. 52, is credited to Cuvier. It appears in Cuvier (1816: 153) as Les Triacanthes, but is latinized by Oken (1817: 1183) as *Triacanthus*. Triacanthidae.

*Diodon*, pp. 52, 53, is credited to Linné, and is the same as *Diodon* Linnaeus, 1758. Diodontidae.

*Tropigaster*, pp. 52, 53, is a new genus, with the single included species “*D. auritus* *Schmeid.*” which is the same as *Ostracion auritus* Shaw (1798: 338). *Tropigaster* Billberg, 1833 is a senior synonym of *Acarana* Gray (1835: pl. 98, fig. 2) with the same type species. *Acarana* is better known by the incorrect subsequent spelling *Aracana*, but both names are in current use. *Tropigaster* has never been used after 1833, whereas *Aracana* has been used in low frequency and *Acarana* very rarely after 1899. Google Scholar (2015-09-19) yields more than 25 references to publications mentioning the fish *Aracana*, with more than 20 different single or first authors in the period 1974–2015. *Aracana* therefore has priority by prevailing usage over *Tropigaster* whenever the two are considered to be synonyms (Code Article 23.9.1–2). Aracanaidae.

*Oedaus*, pp. 52, 53, is a new genus, but no species are mentioned and the Latin explanation of the name, “inflatus sum” is insufficient for a diagnosis. The name is thus a nomen nudum.

*Ostracium*, pp. 52, 53, is attributed to Linnaeus. Billberg may have intended it as an improved latinization of *Ostracion* Linnaeus, 1758, based Οστρακτιον, but it must be considered an incorrect subsequent spelling (Code Article 33.3, 33.5). Ostraciidae.

*Tetragonizus*, pp. 52, 53, is a new genus, with the single species *O. cornutus* Linn. (= *Ostracion cornutus* Linnaeus, 1758). It is available, and is a senior objective synonym of *Lactoria* Jordan & Fowler (1902: 279), with the same type-species. *Tetragonizus* has never been used after 1833, whereas *Lactoria* is a well known name. Google Scholar (2015-09-19) returns 505 sources using *Lactoria*; among those there are more than 25 publications published between 1973 and 2014, by more than 25 unique single or first authors. Consequently, *Lactoria* is in prevailing usage and has priority over *Tetragonizus* whenever the two are considered to be synonyms (Code Article 23.9.1–2). Ostraciidae.

*Posthias*, pp. 52, 53, is a new genus, with the single species included *O. tuberculatus* Linn. (= *Ostracion tuberculatus* Linnaeus, 1758). It is available, but a junior objective synonym of *Ostracion* Linnaeus, 1758, having the same type species. Ostraciidae.

*Tetraodon*, pp. 52, 53, credited to Linnaeus, is the same as *Tetraodon* Linnaeus, 1758. Tetraodontidae.

*Orbis*, pp. 52, 53, is credited to Clusius [(Clusius, 1605: 138–149)]. *Orbis* Fischer (1813: 71) is described without species, but is the first available use of *Orbis*. Abe (1949) adds species to *Orbis* Fischer and designates *Tetraodon lineatus* (Linnaeus, 1758) as type species of *Orbis*. Billberg, however, seems to have been the first author to include species in *Orbis*: *O. psittacinus*, *O. punctulatus*, and *O. guttatus* are names proposed for species described by La Cépède as *Tétronon perroquet*, *Ostracion pointillé* and *Tétronon moucheté*, respectively. He also lists *Tétronon étoilé* along with its unavailable Commerson name *cinereus*. The status of the included species are discussed in the species accounts below. *Orbis* Fischer (1813) comes from La Cépède's footnotes under the description of *Tétronon plumier* in La Cépède (1798: 504: “*Orbis minimus non aculeatus. Plumier, dessins sur vélin, déjà cites*“), and *Sphéroïde tuberculé* (La Cépède 1800: 23: “*Orbis minimus non aculeatus. Plumier, dessins déposés dans le cabinet des estampes de la bibliothèque nationale*”). Both descriptions are based on drawings by Charles Plumier, labelled *Orbis minimus non aculeatus*, which is a descriptive label (“small puffer not spiny”) rather than a name. Both drawings have been identified as *Sphoeroides spengleri* (Bloch, 1785), and *Tétronon plumier* is also described as *Tetrodon plumierii* Schneider, 1801 (Cuvier, 1829; Pietsch, 2001). Billberg gives Clusius as author of *Orbis*. The name *Orbis* first appears in Plinius (book 32, chapter 2), and refers to a round, hard fish without scales, consisting entirely of a head. *Orbis* is used frequently by early ichthyologists (cf. Artedi, 1738, Bibliotheca, genus *Ostracion*; La Cépède, 1798). The name was used by Clusius (1605) for some specimens of porcupine fishes (Diodontidae), *Cyclopterus lumpus*, and what looks like a deformed pufferfish (Tetraodontidae). The question is whether to regard *Orbis* as used by Billberg as the same as *Orbis* Fischer, as an independent application of *Orbis*, or as use of a pre-Linnaean name. Although Billberg shows a preference for replacing post-1757 names with classical names, he still adheres to binominal nomenclature. He just has a broad view of applying name priority. It seems unlikely that Billberg is referring to Fischer, especially since his references to tetraodontiform fishes are largely from La Cépède, and he uses one more footnote name (*Tetrodon cinereus*, ...) from La Cépède. Two other post-1757 usages of *Orbis* are recorded in Eschmeyer & Fricke (2015), viz. Müller (1767: 49), and Catesby (1771: 28). Both those works are declared unavailable for zoological nomenclature (Hemming, 1958: Opinion 89; Melville & Smith, 1987: Opinions 259 and 701). It seems unlikely that Billberg used *Orbis* from one of these. Billberg may have picked up the name *Orbis* from Plumier's manuscript name in La Cépède, but this cannot be demonstrated because Billberg makes an explicit reference to Clusius only. Plumier's name is unavailable (Hemming, 1958: Opinion 89, p. 321). Consequently, *Orbis* is to be regarded as a new name from Billberg. It is thus a junior homonym of *Orbis* Fischer. Use of *Orbis* in Billberg does not affect the nomenclatural act of Abe (1949), but the name remains available. The species included by Billberg in *Orbis* are identified below as *Arothron stellatus* (*O. guttatus*, *O. punctulatus*), and *Sphoeroides testudineus* (*O. psittacinus*), which are eligible for type-species fixation (Code Article 67.2.2. [*Orbis*] *cinereus* is an unavailable name, and does not qualify as an originally included species in the sense of the Code (Article 67.2.1). I select here *Orbis psittacinus* as type species of *Orbis* Billberg, 1833. This makes *Orbis* Billberg a junior subjective synonym of *Sphoeroides* Anonymous, 1798, type species *Tetrodon spengleri* Bloch, 1785, besides being a junior homonym of *Orbis* Fischer, 1813. Tetraodontidae.

*Orthragoriscus*, p. 52, *Ortragoriscus*, p. 53, is credited to Gmelin, although *Orthragoriscus* is not from Gmelin (1789) but stems from Plinius (book 32, chapter 2). The name was used by Rondeletius (1554: 424) and made available by Schneider (1801: 510). *Orthragoriscus* is a junior synonym of *Mola* Koelreuter, 1766. *Ortragoriscus* is a misspelling. Molidae.

*Sphæroïdes*, pp. 52, 53, is credited to La Cépède. It is the same as *Sphéroïdes* in La Cépède (1798: fold-out

table; 1800: 22). It was made available as *Sphaeroides* Anonymous (1798a: 676). Billberg makes it available as *Sphaeroides*, which becomes a junior objective synonym of *Sphaeroides* Anonymous, 1798. Tetraodontidae.

*Ooides*, p. 52, *Ooides*, p. 53, is credited to La Cèpède. It is apparently the same as *Ovoïdes*, a French name in La Cèpède (1798: 529). It was made available as *Ovoïdes* Anonymous (1798a: 675). Billberg makes it available as *Ooides*, which becomes a junior objective synonym of *Ovoïdes* Anonymous, 1798. The only species included in the *Ovoïdes* and in *Ovoïdes* is *Ovoïdes fasciatus* Anonymous (1798a: 675). Kottelat (2013: 470) selected the holotype of *Tetraodon lineatus* Linnaeus, 1758 as neotype of *Ovoïdes* Anonymous, 1798. Because *T. lineatus* is the type species of *Tetraodon* Linnaeus, that act makes *Ovoïdes* an objective synonym of *Tetraodon*. Billberg did not mention any species in *Ooides*, but because it is based on *Ovoïdes*, and the only species associated with *Ovoïdes* is *Ovoïdes fasciatus*, I assign that species to *Ooides*. *Ovoïdes*, *Ooides* and *Tetraodon* then become objective synonyms with *Tetraodon* having priority. Tetraodontidae.

*Chironectes*, pp. 52, 53, is credited to Cuvier, and is the same as *Chironectes* Cuvier (1817: 418), preoccupied by *Chironectes* Illiger, 1811 in Mammalia, and a junior synonym of *Antennarius* Daudin (1816). Antennariidae.

*Lophius*, pp. 52, 53, is credited to Artedi. *Lophius* was used by Artedi (1738, Genera: 62; Synonymia: 87). It is the same as *Lophius* Linnaeus, 1758. Lophiidae.

*Brachionus*, pp. 52, 53, is expressly a new name for *Malthe* Cuvier. It is available but invalid as an unnecessary replacement name for *Malthe* Cuvier (1816: 311). It is also a junior homonym of *Brachionus* Pallas (Rotifera), and junior synonym of *Ogcocephalus* Fischer, 1813. Ogcocephalidae.

*Cyclopterus*, p. 52, credited to Linnaeus, is the same as *Cyclopterus* Linnaeus, 1758. Cyclopteridae.

*Liparis*, pp. 52, 53, is credited to Plinius. Plinius (book 32, chapter 11) lists an animal named *Liparis*. *Liparis* was made available by Scopoli (1777: 453). Liparidae.

*Aphrus*, p. 52, 53, is said to be a fish name used by Aristophanes (“Ἀφρός Piscis nomen Aristophani”) on p. 53. No species is included and the name is a nomen nudum as there is no descriptive information to enable identification of the taxon. Billberg’s Swedish name *skumfisk* (foam fish), translated from the Greek *aphros*, foam, gives no clue. *Aphros*/*Ἀφρός* is mentioned by Salvianus (1559: 3), but there the name refers back to Aristoteles and apparently it was one of several general terms for small fishes, such as anchovies and silversides in Antiquity (cf. Thompson, 1947: 21; Dalby 2003: 15).

*Naucrates*, p. 53, is credited to Oken. No reference is given, and the name is not found in Oken (1816, 1817). It is likely the same as *Naucrates* Rafinesque Schmaltz, 1810. Carangidae.

*Gobiesox*, pp. 52, 53, without reference, is the same as *Gobiesox* La Cèpède, 1800. Gobiesocidae.

*Lepadogaster*, pp. 52, 53, credited to La Cèpède, is the same as *Lepadogaster* Goüan (1770: 106). La Cèpède (1800: 73) has a redescription with reference to Goüan (1770). Gobiesocidae.

*Echeneis*, pp. 52, 53, is credited to Aristoteles. It is the same as *Echeneis* Linnaeus, 1758. It is mentioned in Aristoteles (*Historia Animalium*, book 2, chapter 14) as Ἐχενήϊς. Echeneididae.

*Ophiocephalus*, pp. 52, 53, is listed without reference. It is probably the same as *Ophiocephalus* Bloch (1793: 137), a junior synonym of *Channa* Scopoli, 1777. Channidae.

*Syngnathus*, pp. 52, 53, is credited to Artedi. It is the same as *Syngnathus* Linnaeus, 1758, based on *Syngnathus* in Artedi (1738, Synonymia: 2; Genera: 1). Syngnathidae.

*Hippocampus*, p. 52, is not commented. It is probably the same as *Hippocampus* Rafinesque Schmaltz (1810a: 18). Syngnathidae.

*Solenostoma*, p. 52, is credited to Klein. Klein (1744), in which the name first appears, as *Solenostomus* (p. 23), is a pre-1758 work, and *Solenostomus* there covers *Fistularia*, *Macroramphosus*, *Centriscus* and species of Syngnathidae. The citation in Walbaum (1792: 582; 1793: 94) is considered unavailable (Hemming, 1958: Opinions 5 and 21). The name also appears, credited to Klein, in Anonymous (1778: 32; 1779: 190), a work considered to be non-binominal (Hemming, 1958: Opinion 89). *Solenostoma* is available from Duméril (1805: 106). It is a synonym of *Solenostomus* La Cèpède, 1803. By indication of the Swedish name, “Pipmunn”, it is obvious that Billberg refers to La Cèpède’s and Duméril’s concept of *Solenostomus*. Fistulariidae.

*Aulostoma*, pp. 52, 53, is credited to Commerson. La Cèpède made good use of a manuscript by Commerson, but *Aulostomus* first appears in La Cèpède (1803: 356), without credit to Commerson for the name. *Aulostoma* in Duméril (1805: 138), however, gives credit to Commerson. *Aulostoma* listed by Billberg (1833) is the same as *Aulostomus* La Cèpède, 1803. *Aulostoma* is a common incorrect subsequent spelling from Duméril (1805) onward. Aulostomidae.

*Fistularia*, pp. 52, 53, credited to Linnaeus, is the same as *Fistularia* Linnaeus, 1758. *Fistulariidae*

*Centriscus*, pp. 52, 53, credited to Linnaeus, is the same as *Centriscus* Linnaeus, 1758. *Centriscidae*.

*Macrorhynchus*, p. 52, *Machrorhynchus*, p. 53, credited to La Cépède, is the same as Les Macrorhinques in La Cépède (1800: 75), latinized as *Macrorhyncus* by Duméril (1805: 106) with *Syngnatus argenteus* Osbeck, 1765, as type species. *Macrorhynchus* is only listed by Billberg and must be considered as a subsequent incorrect spelling of *Macrorhyncus* Duméril (Code Articles 33.3, 33.5). Neither name is in current use. *Macrorhyncus* is possibly the same as *Prometichthys* Gill, 1893 (cf. Eschmeyer & Fricke, 2015). Eschmeyer & Fricke (2015) date *Macrorhyncus* to Duméril (1806: 342). *Gempylidae*.

**Species mentioned by Billberg.** *Raja Forskohlii*, p. 51, is a replacement name for “R. Uarnak Forsk.,” i.e., Uarnak, a vernacular name listed in Forskål (1775: XX). It is available by indication as *Raja forskohlii* Billberg, 1833. It is a junior objective synonym of *Himantura uarnak* (Gmelin, 1798: 1509), also based on Forskål’s Uarnak. *Dasyatidae*.

*Raja Arabica*, p. 51, is a replacement name for [R.] Sephen Forsk., i.e., *Raja sephen* Forskål (1775: XX). As an unnecessary replacement name it is available as *Raja arabica* Billberg, 1833. It is a junior objective synonym of *Pastinachus sephen* (Forskål, 1775). *Dasyatidae*.

*Myliobatis Marcgravii*, p. 51, is a replacement name for [M.] Naxari Macgr. [*sic*] Duméril. This taxon is not recognizable, but probably concerns *Narinari* in Marcgravius (1648: 175). *Myliobatis* was described by Cuvier (1816: 137), crediting Duméril for the name, however. Marcgravius’ *Narinari* is listed as a species of *Myliobatis* by Cuvier (1816: 138). *Myliobatis marcgravii* is available from Billberg only if considered the same as Marcgravius’ *Narinari*, and likely as that may be, there is sufficient doubt as to the identity of the referred species to consider this a nomen nudum. Euphrasén (1790: 217) already applied the name *Narinari* as *Raja narinari* based on Marcgravius’ description and a specimen from the Caribbean, and it is valid as *Aetobatus narinari* (Euphrasén, 1790). Presumably *Myliobatidae*.

*Cephaloptera Dumerillii*, p. 51, is a new species based on “Molubar Lacep.,” i.e., La raie Molubar in La Cépède (1798: 151), which is the same as *Raja mobular* Bonnaterre, 1788. *Cephaloptera dumerillii* is a junior objective synonym of *Mobula mobular* Bonnaterre, 1788. *Myliobatidae*.

*M. [sic] Lacepedei*, p. 51, is a new species for La raie Manatia in La Cépède (1798: 160), latinized *Raja Manatia* Schneider (1801: 364). It is available as *Cephaloptera lacepedei* Billberg, 1833, but is a junior objective synonym of *Raja manatia* Schneider, 1801 and junior subjective synonym of *Manta birostris* (Walbaum, 1792). The “M.” is obviously an error for “C.” as in *Cephaloptera*. *Myliobatidae*.

*M. [sic] Rissoi*, p. 51, is a replacement name for [C.] *Massena [sic]*, i.e., *Cephalopterus massena* Risso (1810: 15). The “M.” is obviously an error for “C.” as in *Cephaloptera*. By being an unnecessary replacement name it is available as *Cephaloptera rissoi* Billberg, 1833. It is a junior objective synonym of *Cephalopterus massena* Risso, 1810, in the synonymy of *Mobula mobular* (Bonnaterre, 1788). *Myliobatidae*.

*Scylia Russelii [sic]*, p. 51, is provided as a name for “Boku Sorsa Russ.,” i.e., apparently the Bokee sorrah described and illustrated by Russell (1803, I: 10, pl.16). It is available by indication as *Scylia russelii* Billberg, 1833. Although the spelling differs, the work and its local names are distinctive enough to recognize the source and particular drawing. This species is probably the same as *Chiloscyllium punctatum* Müller & Henle, 1839 according to Compagno (2001: 176). Blainville (1816: 121) published the name *Squalus russellianus* without supporting diagnostics and Fowler (1941: 86) assumed that it was based on Russell’s Bokee Sorrah, and thus available. Likely as that may be, there is no clue in Blainville (1816) as to which species is intended, and *Squalus russellianus* is clearly a nomen nudum. *Scylia Russelii* Billberg remains a species inquirenda. *Hemiscylliidae*.

*Scylia isabellina*, p. 51, is a replacement name for “Isabella Gmel.,” i.e. *Squalus isabella* Gmelin (1789: 1489), an objective homonym of *Squalus isabella* Bonnaterre (1788: 6), both based on the description by Broussonet (1780: 648) of a shark named by him with the French name *isabelle* alluding to the buckskin or pale beige colour. Both Gmelin and Bonnaterre treat *Isabella* as a noun (with capital I). The species is now placed in the genus *Cephaloscyllium* and is usually incorrectly cited as *C. isabellum* (e.g., Eschmeyer & Fricke, 2015). *Scylia isabellina* is available by being an unnecessary replacement name. It is a junior objective synonym of *Squalus isabella* Gmelin, 1789 and Bonnaterre, 1788. *Scyliorhinidae*.

*Anodon macropterus*, p. 51, is a replacement name for *Massasa* Forsk., i.e., *Squalus massasa* Forskål, 1775, an unavailable name. It is available by indication, not as unnecessary replacement name, as *Anodon macropterus* Billberg, 1833. It is a junior synonym of *Squalus messasa* Bonnaterre, 1778. Forskål (1775:X) listed *Squalus*

massasa as “17. SQUALUS: a) MASSASA, *Djiddæ*; MAFREKA, *Lohajæ*. Dentibus nullis; pinnis pect. longis. A Charcharia diversus.” Evidently Forskål refers to local names at Jeddah and Al Luḥayyah, but does not provide a single name for the taxon. In selecting just Massasa, Bonnaterre and Billberg provide one name for the diagnosis, but it remains a species inquirenda. Carcharhinidae.

*Anodon cirrhosus*, p. 51, is a replacement name for “Kilmal Forsk.,” actually *Squalus kumal* Forskål, 1775. As an unnecessary replacement name it is available as *Anodon cirrhosus* Billberg, 1833. It is a junior objective synonym of *Squalus kumal* Forskål, 1775, which is probably a senior synonym of *Nebrius ferrugineus* (Lesson, 1831). Ginglymostomatidae.

*Anodon cornutus*, p. 51, is a replacement name for “*edentulus* Brunn.,” i.e., *Squalus edentulus* Brünnich, 1768, called L’Aodon cornu in La Cepède (1798: 300), but with a footnote reference identifying it as the same as *S. edentulus*. By being an unnecessary replacement name, it is available as *Anodon cornutus* Billberg, 1833. It is a junior objective synonym of *Squalus edentulus* Brünnich, 1768, junior homonym of *Aodon cornutus* Anonymous, 1798, and *Aodon cornutus* Rafinesque Schmaltz, 1810, and junior subjective synonym of *Mobula mobular* (Bonnaterre, 1788). Myliobatidae.

*Zyganna voracissima*, p. 51, is a replacement name for “*Zygaena* Linn.,” i.e., *Squalus zygaena* Linnaeus, 1758. By being an unnecessary replacement name it is available as *Zyganna voracissima* Billberg, 1833. It is a junior objective synonym of *Sphyrna zygaena* (Linnaeus, 1758). Sphyrnidae.

*Centrina Broussonetii*, p. 52, is a replacement name for “[C.] *americanus* Gmelin”, i.e., *Squalus americanus* Gmelin (1789: 1503). Gmelin based the description of *Squalus americanus* on Broussonet’s (1780: 677) description of the liche. *Squalus licha* Bonnaterre (1788: 12) is also based on Broussonet’s description and has priority as *Dalatias licha* (Bonnaterre, 1788). It was said by Broussonet to be from cap Breton, which Gmelin apparently understood as île de cap-Breton, an island in Nova Scotia, Canada, at the time a French possession, although he abbreviated the locality to just Breton. Cuvier (1816) was the first to point out that the locality is the city now known as Capbreton, situated north of Bayonne in southwestern France. By being an unnecessary replacement name, *Centrina broussonetii* is available from Billberg, 1833. It is a junior objective synonym of *Squalus americanus* Gmelin, 1789, itself a junior objective synonym of *Dalatias licha* (Bonnaterre, 1788). Dalatiidae.

*Acipenser vulgaris*, p. 52, is a replacement name for “[A.] “Hurio Linn.” Acipenser Hurio cannot be verified from Linnaeus. Hurio is apparently a misspelling or misprint for *Sturio*, and from the context the species in question is *Acipenser sturio* Linnaeus, 1758. “Hurio” is considered to be “inappropriate” by Billberg. By being an unnecessary replacement name, *Acipenser vulgaris* is available from Billberg, 1833. It is a junior secondary homonym of *Sturio vulgaris* Rafinesque Schmaltz, 1810. Both are junior synonyms of *Acipenser sturio* Linnaeus, 1758 by being unnecessary replacement names. Acipenseridae.

*Acipenser ichthyocolla*, p. 52, is a replacement name for “[A.] *Huso* Linn.,” i.e., *Acipenser huso* Linnaeus, 1758. The species name is credited to Rondelet, but *Acipenser ichthyocolla* is available by being an unnecessary replacement name with Billberg as author. It is a senior secondary homonym of *Huso ichthyocolla* Bonaparte, 1846. Both are junior synonyms of *Acipenser huso* Linnaeus, 1758. Acipenseridae.

*Cotilla frenata* is a new name for the “Balliste bridé Lacepede”, i.e., Le Baliste bridé in La Cepède (1798: 378), a French name. It is available by indication as *Cotilla frenata* Billberg, 1833. It is a junior objective synonym of *Balistes capistratus* Shaw (1804: 417), and *Sufflamen fraenatus* (Latreille, 1804:74), also based on the Baliste bridé.

*Monacanthus Blochii*, p. 52, is a new species for “*tomentosus* Bloch”, i.e., Billberg considers *Balistes tomentosus* presented in Bloch (1786: pl. 148, fig. 1) as different from *Balistes tomentosus* Linnaeus (1758), currently in the genus *Acreichthys* Fraser-Brunner. *Monacanthus blochii* Billberg, 1833 is available by indication. Bloch’s specimen in the Museum für Naturkunde, Berlin (ZMB), with catalogue number ZMB 4167, was identified by Paepke (1999: 100) as *Acreichthys tomentosus*. *Monacanthus blochii* Billberg is consequently a junior subjective synonym of *A. tomentosus*, with ZMB 4167 as holotype. Monacanthidae.

*Monacanthus sebae*, p. 52, is proposed for *Balistes hispidus* as described by Gmelin (1789: 1463), which Billberg considers to be different from *Balistes hispidus* Linné (1766). *Monacanthus sebae* Billberg, 1833, is available by indication. Because Gmelin is only repeating Linnaeus’ (1766: 405) description it seems not possible that more than one species is included. *Monacanthus sebae* is thus a junior objective synonym of *Balistes hispidus* Linné, 1766, currently *Stephanolepis hispidus*. Monacanthidae

*Monacanthus Cuvieri*, p. 53, is a new species for “Monoceros Bloch”, i.e., *Balistes monoceros* in Bloch (1786: pl. 147) and Schneider (1801: 462) which Billberg considers to be different from *M. monoceros* Linnaeus, 1758, currently in the genus *Aluterus* Cloquet, 1816. It is available by indication as *Monacanthus cuvieri* Billberg, 1833. Bloch’s specimen, ZMB 5195 was identified by Paepke (1999: 100) as *Aluterus monoceros* (Linnaeus, 1758), of which *M. cuvieri* is then a junior subjective synonym, with ZMB 5195 as holotype. Monacanthidae.

*Monacanthus Marcgravii*, p. 53, is a new name for “Acaramuca [sic] Marcgr.”, i.e., the Acaramucu in Marcgravius (1648: 163). It is available by indication as *Monacanthus marcgravii* Billberg, 1833. Marcgravius’s Acaramucu has been identified as *Aluterus monoceros* (Linnaeus, 1758) at least since Gmelin (1789: 1462) and *M. marcgravii* is tentatively a junior synonym of *A. monoceros*. Monacanthidae.

*Tropigaster auritus*, p. 53, is a new combination for “*D. auritus* Schneid.” Schneider (1801: 561) refers to *Ostracion auritus* Shaw, 1798. The current combination is *Aracana aurita* (Shaw, 1798). Ostraciidae.

*Tetragonizus cornutus*, p. 53, is a new combination for *Ostracion cornutus* Linnaeus, 1758, current combination *Lactoria cornuta*, as *Lactoria* has priority over *Tetragonizus* by prevailing usage. Ostraciidae.

*Posthias tuberculatus* is a new combination for *Ostracion tuberculatus* Linnaeus, 1758, currently considered a junior synonym of *Ostracion cubicus* Linnaeus, 1758. Ostraciidae.

*Tetraodon striatus*, p. 53, is a new species for “[*T.*] *lineatus*, Bl.”. Billberg considers the *Tetrodon lineatus* in Bloch (1786: pl. 141) and Schneider (1801: 503) to be a different species from *T. lineatus* Linnaeus (1758:33). *Tetraodon striatus* Billberg, 1833, is available by indication, with Bloch’s specimen, ZMB 4242, as holotype. The holotype is now lost (Paepke, 1999: 149). It is identified as *T. lineatus* Linnaeus, 1758 by Paepke (1999), making *T. striatus* a junior subjective synonym of *T. lineatus*. Tetraodontidae.

*Orbis Psittacinus*, p. 53, is a new name for “Peroquet [sic] Lacep.”, i.e., Le Tétrodon perroquet in La Cèpède (1798: 477), identified by La Cèpède as *Tetrodon testudineus* Linnaeus (in Gmelin, 1789: 1444), which is the same as *Tetraodon testudineus* Linnaeus, 1758. Although La Cèpède clearly considered the Tétrodon perroquet to be the same as *T. testudineus*, Billberg seems to have missed this information. *Orbis psittacinus* Billberg is thus available by indication. It is a junior objective synonym of *Sphoeroides testudineus* (Linnaeus, 1758). Tetraodontidae.

[*Orbis*] *cinereus*, p. 53, is listed in the reference “*étoilé* [sic] Lac. *cinereus* Commers.”, which refers to Le Tétrodon étoilé in La Cèpède (1798: 483). In the description of Tétrodon étoilé, La Cèpède has a reference to a manuscript name by Commerson, “*Tetrodon cinereus*, nigro guttatus, hispidus setis è basi stellata exortis”, which is non-binominal and thus unavailable. Opinion 89 (Hemming, 1958) suppresses all Commerson names listed as footnotes in La Cèpède’s *Histoire naturelle des poissons*; but maintain them as available when adopted by a later author. Consequently generic names can be adopted from Commerson in La Cèpède (1798–1803), but not the polynomial species names. *Tetrodon cinereus* ... is unavailable by being polynomial. “*Orbis cinereus*” in Billberg is not available by indication, because Billberg gives equal status to Tétrodon étoilé and “*cinereus* Commers.” It is therefore not obvious what Billberg’s intention is. Tétrodon étoilé was made available as *Tetrodon stellatus* (Anonymous, 1798: 683), and independently as *Tetrodon lagocephalus* var. *stellatus* (Schneider, 1801: 503). The current combination is *Arothron stellatus* (Anonymous, 1798). Tetraodontidae.

*Orbis punctulatus*, p. 53, is a new name for “pointillé Lac.”, i.e., Le Tétrodon pointillé in La Cèpède (1798: 485). *Orbis punctulatus* Billberg, 1833, is available by indication, but is a junior objective synonym of *Tetrodon pseudopterus* Schneider (1801: 508) and *Tetrodon punctatus* Shaw (1804: 447) which are also based on the Tétrodon pointillé. *Tetrodon pseudopterus* was considered a junior synonym of *Arothron stellatus* (Anonymous, 1798) by de Beaufort (in Weber & de Beaufort, 1912: 399). Tetraodontidae.

*Orbis guttatus*, p. 53, is a new name for “moucheté Lac.”, i.e., Le Tétrodon moucheté in La Cèpède (1798: 491), a French name. *Orbis guttatus* Billberg, 1833, is available by indication. It is a junior objective synonym of *Tetrodon commersoni* Schneider (1801: 508), also based on the Tétrodon moucheté, and in its turn considered to be a junior synonym of *Arothron stellatus* by de Beaufort (in Weber & de Beaufort, 1912: 399). Tetraodontidae.

**The new pipefishes.** Three species of pipefishes, family Syngnathidae, are introduced by Billberg (1833), viz., *Syngnathus pustulatus*, *S. virens* and *S. palmstruchii*, said to be have been found and painted in life by by Johan Wilhelm Palmstruch on a journey in 1804 to the Bohuslän archipelago. There is no mention of specimens, and it seems reasonable to assume that the descriptions are based entirely on the drawings. There are no specimens in the Swedish Museum of Natural History that can be identified as being the pipefish specimens described by Billberg.

Palmstruch (1770–1811) initiated publication of two major illustrated multivolume works, *Svensk botanik* (Swedish Botany) and *Svensk zoologi* (Swedish Zoology), and produced a considerable number of the drawings for

these. Upon Palmstruch's passing, Billberg acquired the publication rights and continued the two series until 1822, when the Royal Academy of Sciences took over, continuing until 1843 and 1825, respectively. The drawings of pipefishes probably formed part of the legacy of Palmstruch intended for the *Svensk zoologi*.

*Syngnathus pustulatus* is diagnosed by Billberg (p. 54, fig. 1) as having only slightly angled, olivaceous body which is darker above, with white drop spots and a grey-brown spotted, white lateral line. Counts are D. 32, P. 14, C. 10, A. 0. The anal fin is missing from the drawing.

*Syngnathus virens* is diagnosed (p. 54, fig. 2) as having body with 16 rings, green color, belly 7-angled; caudal peduncle basally 6-angled, posteriorly square in cross-section. Counts: D. 31, P. 10, C. 11, A. 0. The anal fin is not showing on the drawing.

*Syngnathus palmstruchii* is diagnosed (p. 55, fig. 3) as without caudal fin, body almost plump with 35 rings, back 4-angled and caudal peduncle square in cross-section. Dorsal fin with 43 rays.

Six species of pipefishes are known from the Swedish coast (Dawson, 1986; Kullander *et al.*, 2012), viz., *Entelurus aequoreus* (Linnaeus, 1758), *Nerophis ophidion* (Linnaeus, 1758), *N. lumbriciformis* (Jenyns, 1835), *Syngnathus acus* Linnaeus, 1758, *S. rostellatus* Nilsson, 1855, and *S. typhle* Linnaeus, 1758.

I identify *S. palmstruchii* as a junior synonym of *Entelurus aequoreus* (Linnaeus, 1758) based on the colour pattern, dorsal-fin position, absence of caudal fin, ventrad-slanting lateral bony ridge, and position of the eggs on the belly. The caudal fin is absent in *Nerophis lumbriciformis* and *N. ophidion*. A rudimentary caudal fin with 4–9 rays may be present in *E. aequoreus*, but it is small and may be absent (Kullander *et al.*, 2012). Brooding males of *Nerophis* and *Entelurus* carry the eggs on the belly as shown on Palmstruch's drawing of *S. palmstruchii*. In *Entelurus* the lateral bony ridge slants from the midlateral to join the lateroventral ridge; *Nerophis* is similar, but the ridges are less prominent. *Syngnathus palmstruchii* is illustrated with a ventrad-slanting lateral body ridge and a slender tapering tail. It is not unreasonable to consider that the caudal fin in this specimen may have been absent or it was overlooked by the artist. The drawing agrees with *E. aequoreus* in the colour pattern characteristic of that species, with indicated narrow dark vertical bars arranged in pairs, and a dark stripe on the head, passing through the eye. The snout is long and straight, unlike in *N. lumbriciformis*. The dorsal fin is situated chiefly on the trunk, with only a few rays on the tail, unlike in *N. lumbriciformis* and *N. ophidion* in which the major part is situated on the tail. The counts agree with *N. ophidion* (D. 32–44; trunk rings 28–33) and *E. aequoreus* (D. 37–47; trunk rings 28–31), but not with *N. lumbriciformis* (D. 24–28; trunk rings 17–19).

*Syngnathus pustulatus* and *S. virens* are illustrated with caudal fin, as present in *S. acus*, *S. rostellatus* and *S. typhle*. Although they are illustrated and described as lacking an anal fin, the pectoral fin is illustrated and the pectoral fin-ray counts are provided. It appears that the small anal fin present in species of *Syngnathus* has been overlooked by the artist, and if that is the case the two species represent *Syngnathus*, in which both anal and pectoral fins are present, rather than *Entelurus* or *Nerophis* in which those fins are absent. The lateral ridge is illustrated as ascending from midlateral to become dorsal posterior to the dorsal fin, as in species of *Syngnathus*, but unlike in *Nerophis* or *Entelurus*, in which it flexes ventrad.

*Syngnathus pustulatus*, described and figured as a white-spotted, long-snouted and deep-snouted species with 14 pectoral-fin rays, agrees with *Syngnathus typhle*, with which Billberg compares his new species, noting that *S. pustulatus* is more uniformly wide. The dorsal-fin count (32) is lower than in *S. typhle* (34–42), *S. acus* (34–45) or *S. rostellatus* (33–35). The pectoral-fin count agrees only with *S. typhle* (13–17). The illustration shows a marsupium on the tail, as is characteristic of brooding male *Syngnathus*.

*Syngnathus virens* is identified as *S. typhle* based on the presence of a caudal fin, dorsad-slanting lateral ridge, green colour, long snout, and short tail. The drawing agrees with *S. rostellatus* in greenish colour, and pectoral-fin ray count 10 (10–13 in *S. rostellatus* according to Kullander *et al.*, 2012), but all three species of *Syngnathus* may show a greenish hue, in addition to which *S. acus* has 10–13 pectoral-fin rays. The only species that is predominantly greenish is *S. typhle*, which agrees with the drawing with the very long snout, longer than half the head (shorter or equal half head in *S. rostellatus* and *S. acus*). The snout to head length-ratio are about the same in the drawings of *S. pustulatus* (27/16) and *S. virens* (28/16). The trunk and tail are of about the same length. In *S. typhle* the tail is only slightly longer than the trunk, and in *S. acus* and *S. rostellatus* it is distinctly longer than the trunk. The fin counts in the text match exactly those of the dark lines in the fins on the drawings of *S. pustulatus* and *S. virens*. On the other hand the ring number cannot be obtained from the drawings of *S. pustulatus* or *S. virens*, although it is given for *S. virens* in the text. No marsupium is evident on the drawing and Billberg notes that *S. virens* is similar to *S. pustulatus* except that the tail is slenderer. Apparently, Billberg was not familiar with

syngnathid morphology and did not recognize the marsupium in *S. pustulatus* and *S. palmstruchii* as such. The number of trunk rings is given as 16, which is within the range for *S. typhle* and *S. rostellatus* (13–17; Kullander *et al.*, 2012) but less than in *S. acus* (17–21; Kullander *et al.*, 2012). On the drawing the snout and tail proportions, in combination with the green colour point to *S. typhle*.

In conclusion, all syngnathids described by Billberg are synonyms of species described by Linnaeus (1758). None of the names have been used subsequent to the descriptions except in the listing in Lundberg (1872), but all three names are available, and may become valid according to taxonomic research. Neotypes are not needed because no nomenclatural problem is associated with Billberg's syngnathids.

**Billberg's sources.** Billberg (1833) is a literature study. Even the new pipefishes are described only from drawings. Practically all names referred to by Billberg are given a source, and nearly all of those match names in La Cépède (1798) and Cuvier (1816). The exceptions are *Naucrates* Oken, and *Exormiston*.

That Billberg copied references from Cuvier's *Règne animal* is obvious from the very selective citations of other works, and his frequent references to Cuvier and Duméril. Some new names definitely were based on information in Cuvier (1816). The texts in Cuvier 1816 and Cuvier (1829) dealing with species cited by Billberg are for the most part identical or almost identical except for the correction of spelling errors in the 1829 volume. Because Billberg uses the spelling *Acaramuca*, as in Cuvier (1816: 153), and not the correct *Acaramucu* as in Cuvier (1829: 374), it seems likely that Billberg perused only the first edition of the *Règne animal* (Cuvier, 1816).

The following serve as examples:

*Monacanthus Cuvieri* refers to Cuvier (1816: 153): "Le *monoceros* de Bl., qui est différent, 147".

*Monacanthus marcgravii* is from Cuvier (1816: 153), "*Acaramuca*, Margr., 163, encore différent des trois précédens [sic]".

*Monacanthus blochii* is distinguished based on Cuvier (1816: 152): "*Bal. tomentosus*, id.[= Bl.], 148, qui n'est pas celui de Linnaeus, mais bien le *pira a ca*, Margr. 154."

*Monacanthus sebae* is also from Cuvier (1816: 152), who diagnoses true *Balistes hispidus* with extendible abdomen ("*B.*[=*Balistes*] à *brosses*, *bal. scopas*, Commers. Lac. I, XVIII, 3, conforme à la description que Lin. donne de l'*hispidus*, mais non au caractère ni à la fig. de Seba qu'il cite") and lists the fish on a Seba drawing without extendible abdomen as "*Bal. hispidus*. L. Seb. III, XXXIV, 2". Billberg did not observe that Cuvier maintained the name *B. hispidus* for Linnaeus's material and considered only the reference to the description and illustration in Seba (1759: plate 34, fig. 4) to represent a different species. Consequently Billberg's *M. sebae*, based on a reference to Gmelin (1789) is an objective synonym of *B. hispidus* Linnaeus, 1766, and Seba's species went without a name. Seba's illustration was identified by Parenti and Desoutter-Meniger (2007) as *Stephanolepis hispidus*.

The diagnosis of *Tropigaster* is also clearly from Cuvier (1816: 154), who writes "A corps comprimé, l'abdomen caréné, des épines éparses. *Ost. auritus*, Sh. nat. miscell. IX, no. 338. et gen. zool. V, part. II, pl. 175: le même que le *coffre quatorze piquants*, Lacép. Ann. Mus. IV, LVIII, I et quelques espèces voisines."

*Tetraodon striatus* most likely was inspired by Cuvier (1816: 148): "*Tetr. lineatus*, Bl. 141, très-différent de celui de Lin.", and shows also that Billberg used the first edition of the *Règne animal* rather than the second. In the second edition (1829: 368) the text is different and does not invite to establishing a new species for Bloch's plate: "*T. lineatus*, Bl., 141, dont *Tetr. psittacus*, Bl. Schn., 95, est au moins très voisin."

Because many of La Cépède's (1798) names are absent from Cuvier (1816), but explicitly cited by Billberg, it can be assumed that La Cépède (1798) or a later edition of that work is a second source. He may have had access some other source for the *Exormizus*. Citations of Forskål, Bloch, Gmelin, Russell, Shaw, Gesner, Duméril, La Cépède (1800), even Linnaeus and Artedi, as well as pre-Linnaean authors could have been copied from Cuvier (1816) or La Cépède (1798).

## Discussion

**Billberg on the ichthyological scene.** Billberg's rationale for publishing his ichthyological paper was founded in a perceived lack of a "simplified classification of fishes with carefully arranged genera, conforming to the needs of the times" (*Fiskarnes system så förenkladt och till släkterna så noggrant ordnadt, som svarar mot tidehvarfvets*

*fordran.*) Unfortunately, his review of the genera is both incomplete and inconclusive, and the proposed classification vestigial. His analysis is poorly researched, overlooking or ignoring most of the contemporary literature even for the limited number of species actually dealt with (mainly chondrichthyans and tetraodontiforms). Its substance is a downpour, not to say a flood of names, cited or invented. Even the Swedish fish names in Billberg (1833) are to a large extent constructions which have not been used since.

It is not obvious what Billberg thought would make his own classification better than that of the superior work already available in the early part of the 19<sup>th</sup> Century. Actually his explicit ambition was to have a system with the three main groups skin fishes (Dermichthyes), scale fishes (Lepidichthyes), and Chondrichthyes, but he regrets that the lack of information from a lot of foreign species was so confusing that he had to propose a temporary classification only, with the option to present something more complete later (Billberg, 1833: 49–50). Billberg's classification is quite similar to others of the time, with cartilaginous, soft-rayed, and spiny-rayed fishes as main divisions. Tetraodontiforms and some other groups, most of them combined in an order Schiponopteri, however, are included in the Chondrichthyes. This classification contrasts with Cuvier's (1816) and most other classifications which separate cartilaginous and bony fishes. Billberg apparently believed that his Pegasiiides (Pegasidae) and Schiponopteri have cartilaginous endoskeletons, but these are actually actinopterygians with ossified skeletons. His emphasis on mouth shape as a key character may have been somewhat novel, but the description of the different states is very superficial.

The fish classification by Cuvier (1816; 1829), albeit relatively flat, was well received, and survived into the 1860s when Albert Günther's classification in the *Catalogue of the fishes in the British Museum* (Günther, 1859–1870) took over, at least as a standard in museum collections.

It was probably not only the apparently minimal circulation of the *Linnéska Sällskapets Handlingar* that prevented Billberg's new classification from becoming manifest in the ichthyological literature record. None of the Swedish ichthyological works, from Fries *et al.* (1836–1856) until now, mention Billberg or his 1833 publication. Most likely the academics of his lifetime either found the 1833 paper bizarre or they were already adversaries of Billberg, either because of his lack of academic training, the financial stress characterizing his publishing initiatives, or his position in academic controversies involving other scientists. Both Boethius (1924) and Landell (1999) stress that Billberg was a controversial person among the academics of his time, more of an enthusiast, as Landell (1999) puts it, than a scholar.

Billberg (1833) may be the most overlooked paper in ichthyological history considering the number of taxa concerned, the time (183 years) until the first review, and the fact that it was always available from a national library.

Although it is a relevant question why Billberg published an incomplete fish classification and revised the nomenclature of so many fishes of which he most likely had no first hand experience, using two outdated books and ignoring all contemporary literature, no answer can be given here.

Billberg may, however, to some extent be excused for his frivolities with nomenclature. In those days, there existed no formalized nomenclatural code, and replacing names was not considered entirely inappropriate. In retrospective it is also seen that by ignoring Billberg, his colleagues did him a favour by not exposing his ignorance, and nomenclature a favour by delaying the discovery of Billberg's names until they were invalidated by prevailing usage of later names.

**Billberg and Swedish ichthyology.** Billberg was not quite right in writing that ichthyology was a neglected discipline in his day. Particularly the work of Cuvier provided a mass of information and a reasonable classification. In Sweden, however, fishes were long a neglected taxonomic group as recognized already by Quensel (1806). Although systematic ichthyology may have started with the work of Artedi (1738), Artedi did not have any immediate followers in Sweden. So far only about 250 species of fish have been recorded from Swedish waters, probably below the threshold needed to support a vibrant local ichthyological community, especially since practically all species were already described in the 18<sup>th</sup> and early 19<sup>th</sup> Century. For most of the 18<sup>th</sup> Century, Carl Linnaeus dominated Swedish biology, and there was little room for others. Carl Per Thunberg (1743–1828) succeeded Linnaeus at Uppsala University and published some fish descriptions, but was mainly a botanist. Anders Sparrman (1748–1820), the first curator of the collections of the Royal Swedish Academy of Sciences depended on his work as physician for his living, and was more concerned with birds (Wästberg, 2008). Bengt Euphrasén (1755–1796), the first modern Swedish ichthyologist, died prematurely and in poverty after publishing a few papers and having his manuscript on Swedish fishes rejected by the Academy (Nyberg, 2013). Anders Jahan

Retzius published an updated version of Linnaeus's *Fauna suecica* in 1800 (Retzius, 1800), with little change to the fish part. The fish chapters in Quensel & Swartz (1806) were few. Conrad Quensel (1767–1806) succeeded Sparrman as curator in the Academy. He published a brief revision of flatfishes (Quensel, 1806), but died leaving a larger manuscript unfinished. In 1832 this depressing state changed when Sven Nilsson published his synopsis of Scandinavian fishes, *Prodromus ichthyologicae scandinavicae* (Nilsson, 1832), the last Latin-only ichthyological work in Sweden. It was followed by several faunal works on Scandinavian fishes (between 1814 and 1905 Sweden and Norway formed the United Kingdom of Sweden and Norway). Most important were Fries *et al.* (1836–1856), Nilsson (1855), Lilljeborg (1889–1892), and Smitt (1892–1895). These latter works are very detailed and for the most part accurate. The difference between Nilsson and his followers on the one hand and Billberg on the other is of course that Billberg adhered to the tradition of his birth Century, restricting himself to books, whereas 19<sup>th</sup> Century biologists examined fishes and built collections, most of them associated with the natural history museums in Uppsala, Gothenburg, Lund or Stockholm. It was not Billberg who boosted ichthyology in Sweden.

The lesson from Billberg may thus be that literature studies (like this one) do not advance science in any way (but may be entertaining... for the author), but studying real fish alone brings new knowledge.

**Billberg's indications.** Except for the three pipefishes, all of Billberg's nomenclatural acts are by indication (Code Article 12.2). Four of Billberg's replacement names pose a problem because they are obviously misspelt by Billberg, but on the other hand, the source citation indicates with complete or almost complete confidence which species he intends. "Kilmal Forsk." Is certainly a reference to *Squalus kumal* in Forskål (1775). Obviously the typesetter read the "u" in Billberg's handwriting as "il", and it was not corrected in the proof-reading. The second strange name is the myliobatid ray species "naxari", with Marcgravius as a reference. There is only one publication by Marcgravius and it has a limited number of batoid species (Marcgravius, 1648). One of them is the Narinari, and it seems likely that the type-setter again was guessing with regard to Billberg's handwriting, reading naxari instead of narinari. The third case is the Boku sorsa attributed to "Russ". The only option here is the only work by Russell containing shark names (Russell, 1804), and there is only one name there that fits, namely the Bokee sorrah. Cuvier uses the spellings bokee sorra (1816: 125) and Bokee sorra (1829: 387) in a footnote, and they could easily look like Boku sorsa in bad handwriting. It is unlikely that Billberg consulted the works of Forskål, Marcgravius, or Russell, but probably just adopted citations in Cuvier (1816) as basis for his new names.

In these three cases, identification of the taxa concerned is facilitated by the fact that the works referred to are unique. There is only one publication by Forskål and Marcgravius. Russell published a book about Aleppo, which also contains fish descriptions, but no sharks are included; his book on the fishes of southern India (Russell, 1804), however, contains drawings of chondrichthyans.

The fourth case, "*Acipenser Hurio*" has a reference to Linnaeus, but this particular name cannot be verified in Linnaeus's works, or any other publication that Billberg refers to. From the context it is nevertheless clear that *Acipenser sturio* is intended, and it may derive from a misreading of sturio in the footnote list of references under l'Acipensère Esturgeon in La Cepède (1798: 411). Hurio is used as an alternative common name for *Acipenser huso* Linnaeus, 1758 in a separate entry in the multivolume dictionary by Valmont-Bomare (1800: 195). Hurio is not mentioned in Valmont-Bomare (1791: 201) under the headword Esturgeon where species of *Acipenser* are listed with scientific names. Hurio is listed with the same meaning in later dictionaries (Bosc, 1803, 1817). Those dictionaries cannot have been the source for Billberg's "*A. Hurio*", as they do not use Hurio as a specific name. In a review of Tingry (1803), Anonymous (1811:187) lists *Acipenser Hurio* (original in italics) as a source of isinglass. Tingry (1803: 13) mentions a sturgeon in the Danube but does not cite a scientific name. *Acipenser Hurio* in Anonymous (1811) is a nomen nudum and "Hurio" here may represent another misreading of Sturio.

The Code permits names to be proposed by indication, i.e., reference to some other publication. The criteria for a publication and descriptive data (Article 12.2.1) or an illustration (Article 12.2.7) are fulfilled in the above cases, because the source is identified, but how exact must the reference to the species be? The Code provides no guidance whether names must match exactly or if spelling can deviate within limits. "Kilmal" and "kumal" may seem similar enough for accepting *Anodon cirrhosus* as an available unnecessary replacement name. Boku sorsa is more removed from the target spelling, although distinct enough with reference to Russell to serve as indication for *Scyliia russeli*. Hurio is also obviously just an easily recognized misspelling in the context provided. Naxari, however, is a completely different word from its suggested source, narinari, and its replacement, *Myliobatis marcgravi*, is not accepted here as an available name from Billberg.

In a computerized environment, with spell-checking programs and no possibility of blurred characters, there

must be very low tolerance for variation in spellings. In Billberg's time, handwriting was the writing standard with all its options for interpretation. Considering that handwritten manuscripts were submitted for printing in earlier centuries opens for better understanding of small variations looking like typographic errors, incorrect spellings, nomina nuda, or unjustified emendations, but actually representing interpretation of handwriting for which neither author nor typesetter can be held culpable.

A related problem specific to Billberg is that he probably did not verify the names from the source cited but most likely copied them from Cuvier (1816) or La Cepède (1798). This means that Billberg's references (indications as defined in Article 12.2, particularly 12.2.1) are for the most part only indirect. This is not evident from the paper itself, only obvious in comparison with other publications, and even so, the cited source can usually be located using the information in Billberg only.

External evidence and conjectures about the source of Billberg's nomenclatural statements, however, do not affect the individual acts, which have to be evaluated as they were printed. Billberg's references must be accepted as indications under Article 12.2.1. In the case of La Cepède, whose work appeared in multiple editions, it opens for uncertainty about which edition Billberg refers to but there apparently is no case in Billberg (1833) where the edition might matter for nomenclatural purposes. Article 12.2.1, does not require the bibliographical reference to be extant, complete, correct, precise or unambiguous. Verification is probably implicit, however. If a work mentioned in an indication cannot be found, it is unlikely to be accepted as available, and such references represent prominent nomina nuda in Billberg's paper.

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Almost all the sources Billberg hints at, regardless of age, are available for download or online reading at Internet resources such as those listed above. Practically all early taxonomic literature from Aristoteles onward is available and provided in PDF or similar file formats and enable verification from the source of authorship, availability, and other circumstances of names and nomenclatural acts. The present analysis would have been impossible or at least crippled if it would have depended on analyses of physical books spanning a period of 2000 years of authorships, and more than 500 years of printing, especially since libraries today to a large extent limit access to their older physical books. I would not even have contemplated the task.

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Several of the works referred to by Billberg were published in more than one edition and this particularly applies to the works of the Antiquity (Athenaeus, Plinius, Aristoteles, Aelianus), but also medieval, renaissance, and enlightenment works. References below may represent different editions than those used by Billberg or the works he indirectly refers to.

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